

Renewable Energy *Opportunities* *for Rural Indiana*



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PURDUE UNIVERSITY
Discovery Park Energy Center

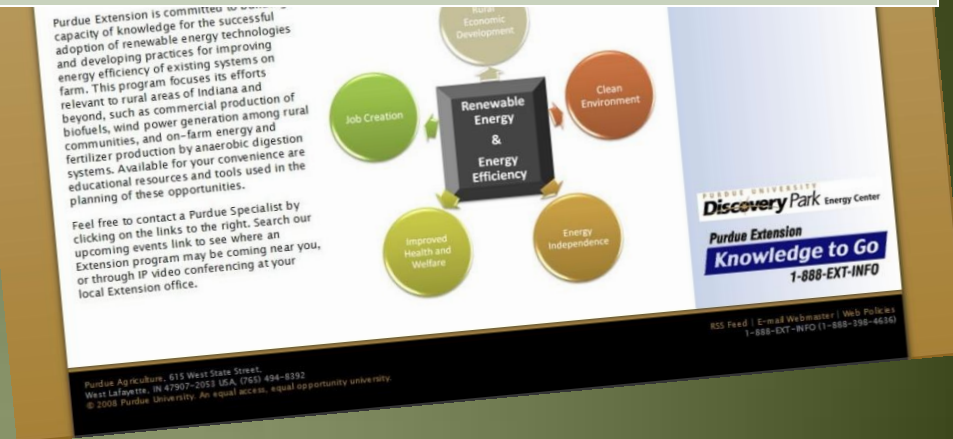
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Enhanced Hub of Information and Tools

www.extension.purdue.edu/renewable-energy



www.ces.purdue.edu/bioenergy



Wind
Energy



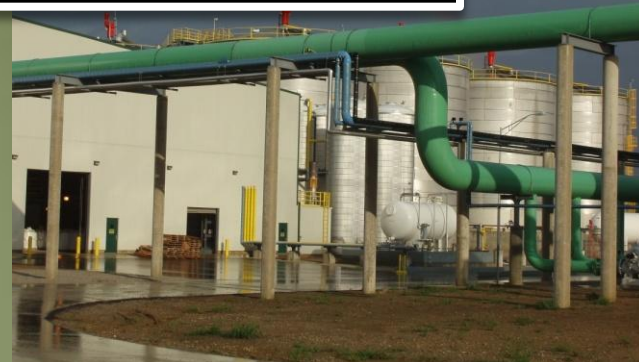
On-Farm Energy
Efficiency



Primary Focus Areas



Biofuels & Co-
Products



Biomass
Energy



NREL and Purdue Extension Partnership for Wind Energy



- Wind Energy Education pilot program:
 - Purdue University
 - Colorado State University
 - Montana State University
 - University of Wyoming



Wind Energy Research at Purdue

- Dr. Doug Adams, and Dr. Sandy Fleeter
 - Research program for wind turbine reliability
 - Collaborative partnering with Sandia National Laboratory

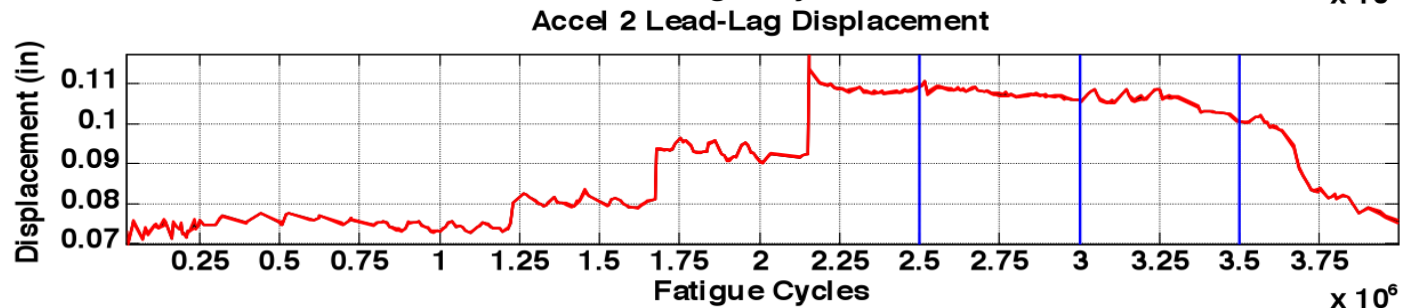
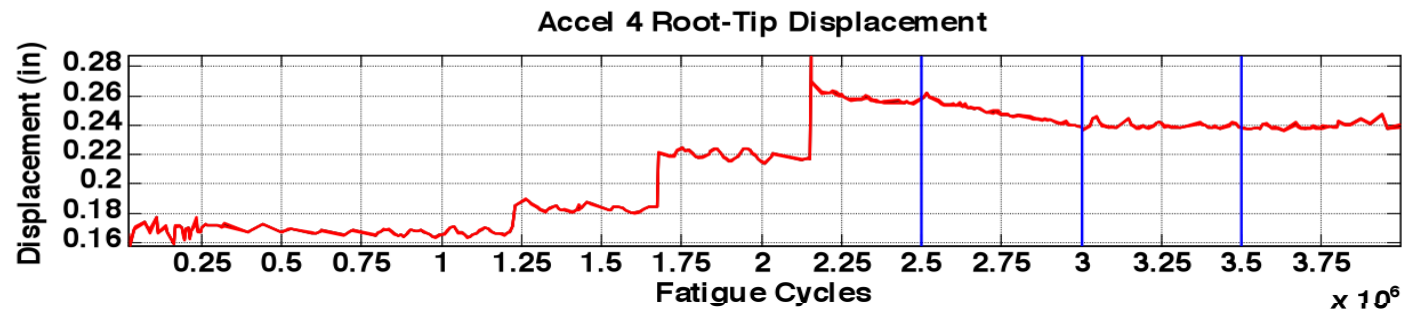
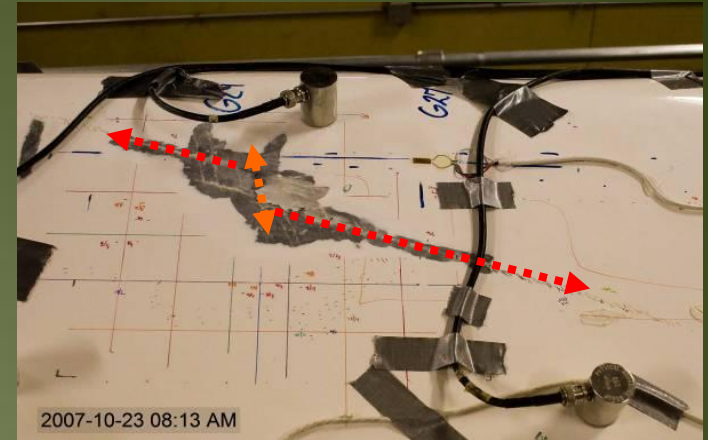
20% by 2030?

- Prognosis could more than double the output of existing wind farms if it were possible to:
 - Sense and control loads along the span of the airfoil.
 - Sense wind at upstream turbines to optimize the operation (yaw, pitch) of downstream turbines.
 - Eliminate unscheduled maintenance/maximize uptime.

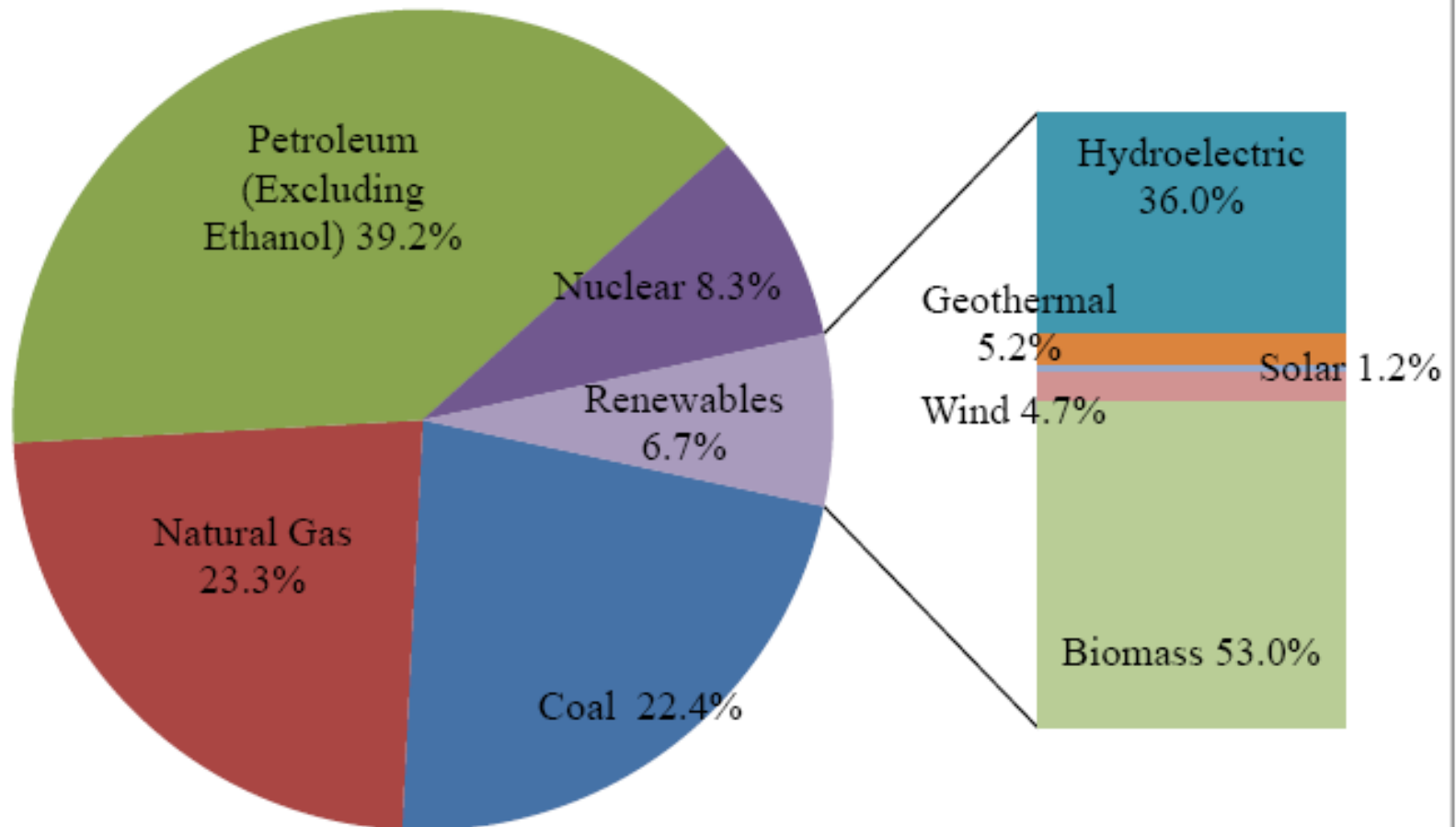


Condition Monitoring

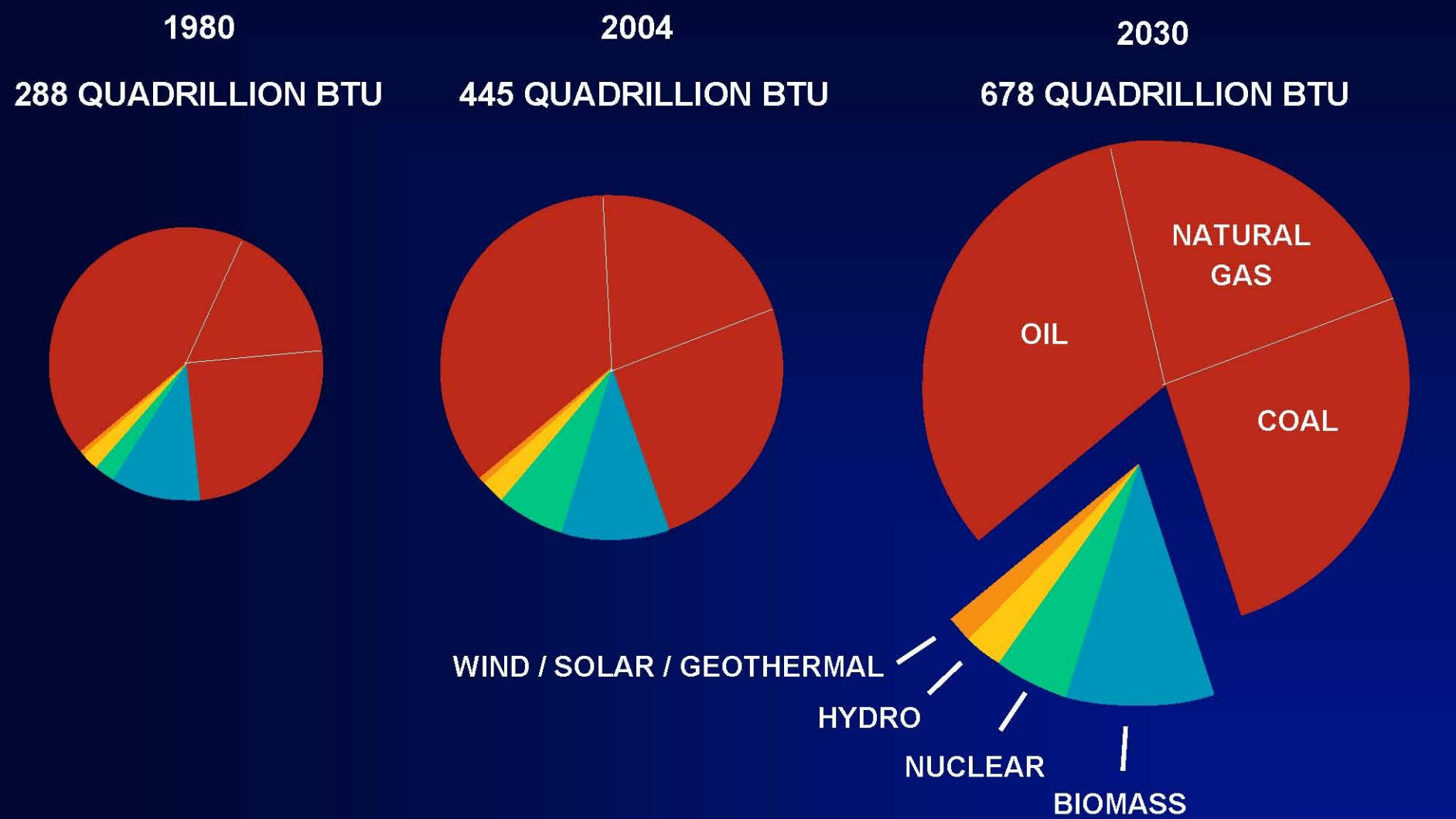
4 M Cycles 20° Crack



U.S. Energy Production, 2007



Coal, Oil, and Natural Gas Will Remain Indispensable



Source: IEA REFERENCE CASE

Top states for each renewable resource for electricity generation

1. Geothermal: California (88%)
2. Solar: California (79%)
3. Hydroelectric: Washington (31%)
4. Wood: Maine (10%)
5. Wind: Texas (27%)
6. Biomass: Oregon (10%)

Source: U.S. Energy Information Administration

State Portfolio Standards

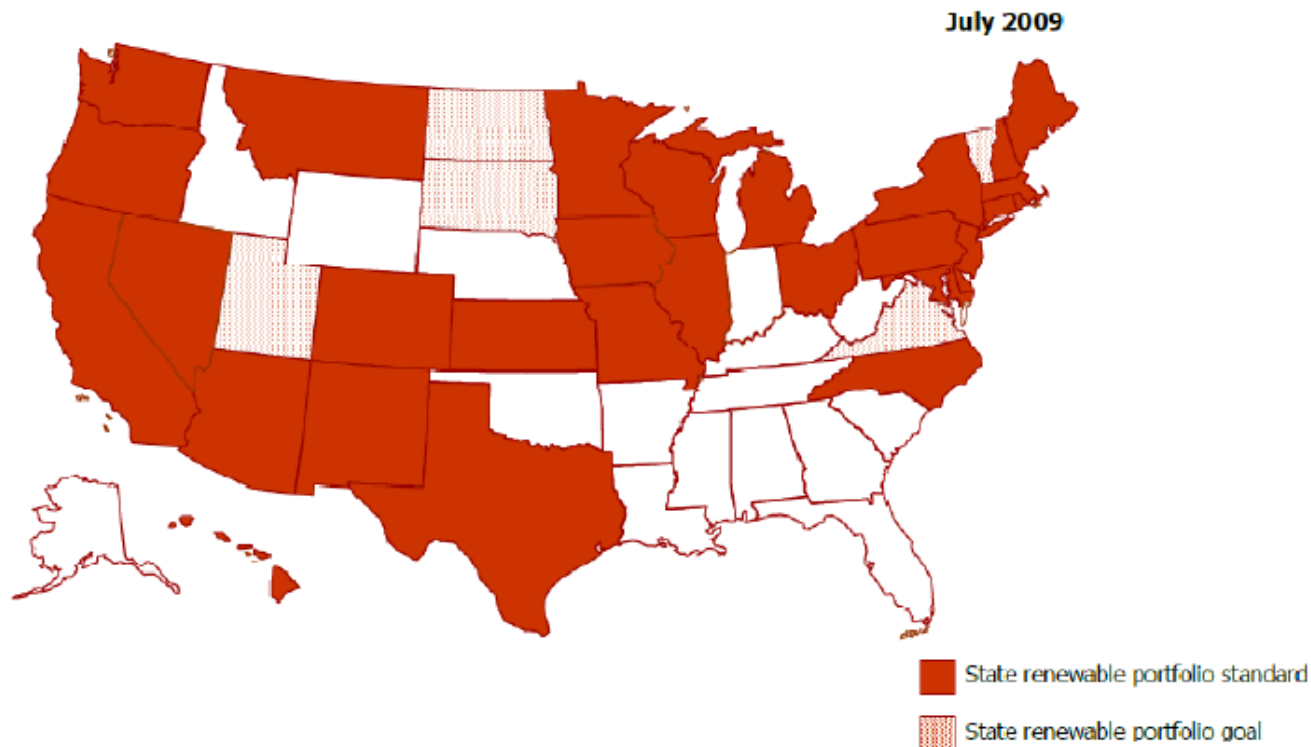
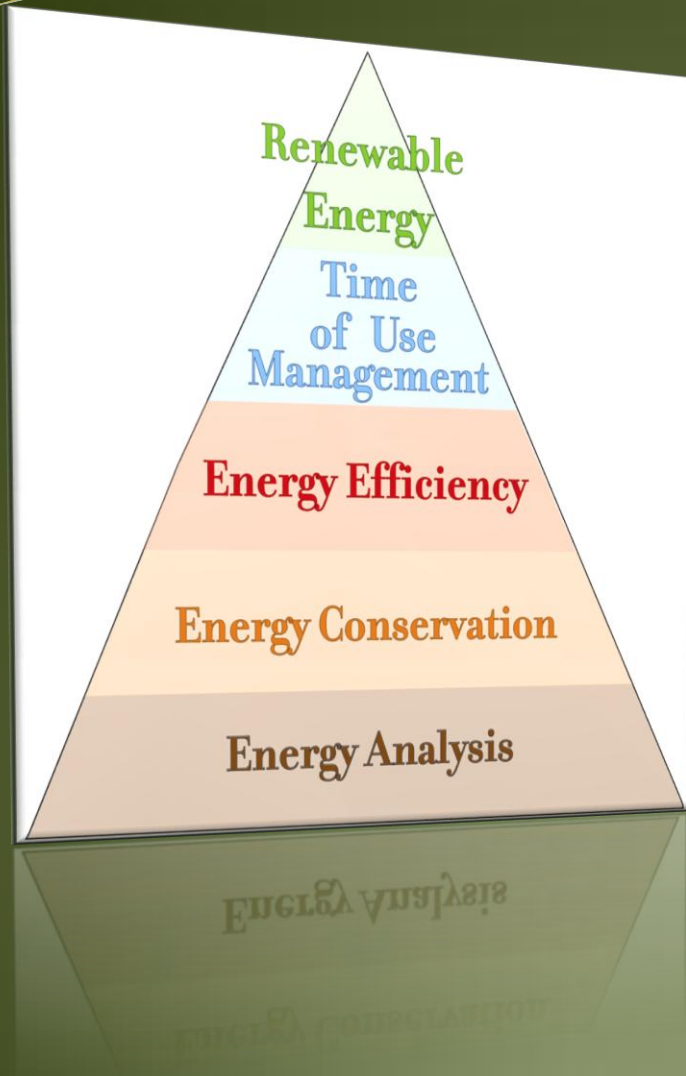


Figure 2-8: Renewable portfolio standards across the U.S. (Source: DSIRE [12])

Small Wind Turbine Considerations





**Renewable
Energy is not the
starting point**

Our Energy Future Must Contain Many Different Components

- We will need many demand and supply side options – there is no silver bullet
- Energy efficiency will be very important – the energy we don't consume is the cheapest resource
- Renewable/Clean energy options have been and will continue to be driven by government policy

Typical Applications

Farms, Homes, Businesses

Off-Grid Water Pumping with Wind



- Supplies water for 120 head of cattle
- 1 kW, 9-ft rotor, 30-ft tower
- Produces ~ 2,000 kWh/yr
- Offsets ~ 1.5 tons CO₂/yr
- Costs ~ \$4,000 installed

Supplementing Grid Power



- Connected to utility grid through house/farm wiring
- 3 kW, 15-ft rotor, 23-ft tower*
- Produces ~ 5,000 kWh/yr
- Offsets ~ 3.8 tons CO₂/yr
- Costs ~ \$10,000

Typical Applications

Farms, Homes, Businesses

Offsetting All Utility Power



- “Net metering” utility power
- 10 kW, 23-ft rotor diameter, 100-ft tower
- Produces ~ 15,000 kWh/yr
- Offsets ~ 14 tons CO₂/yr
- Costs ~ \$35,000

Selling Power Back to Utility



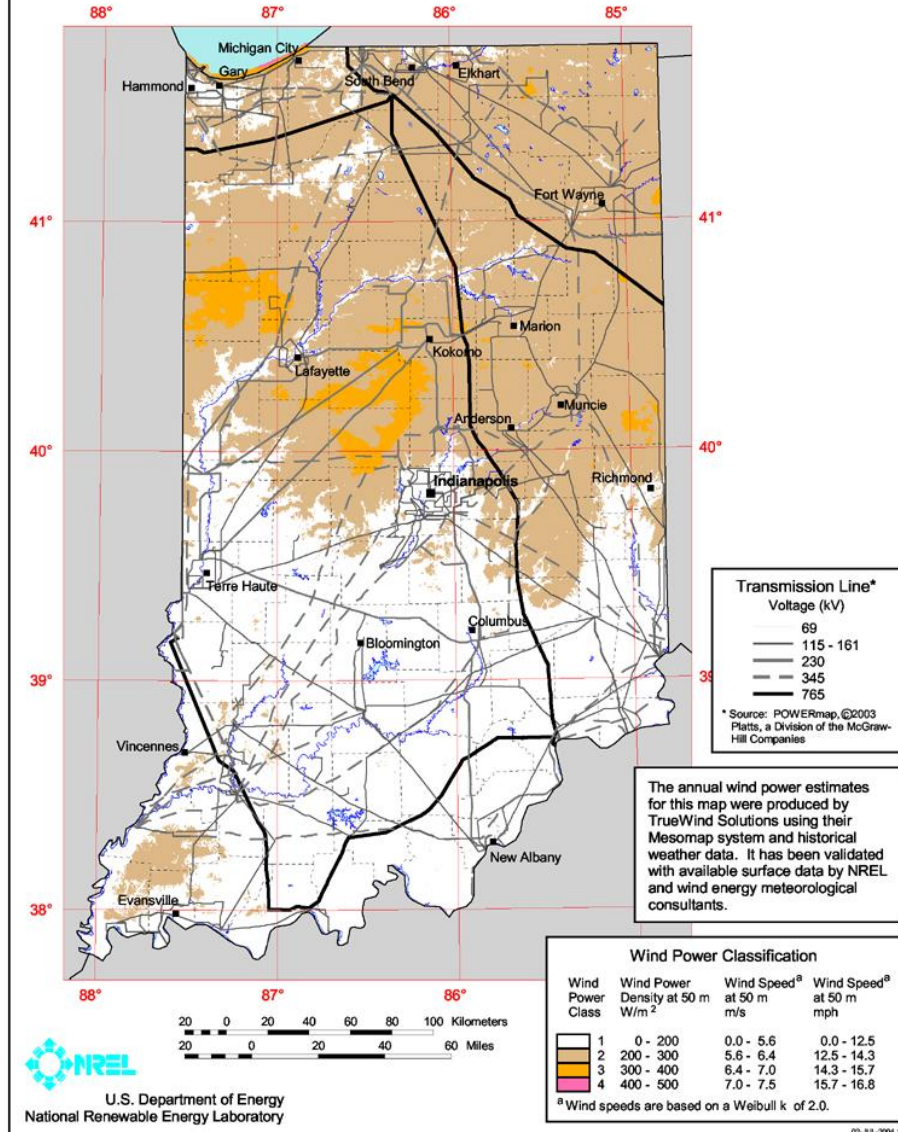
- Excess power sold to utility
- 50 kW, 49-ft rotor, 90-ft tower
- Produces ~120,000 kWh/yr
- Offsets ~ 91 tons CO₂/yr
- Costs ~ \$150,000

Factors to Consider



- Good wind resource: Class 2 or better
- Home or business located on 1 acre or more of land
- Average monthly electricity bills \geq \$100 for 10 kW system, \geq \$50 for 5 kW system
- Zoning restrictions, economic incentives

Indiana - 50 m Wind Power



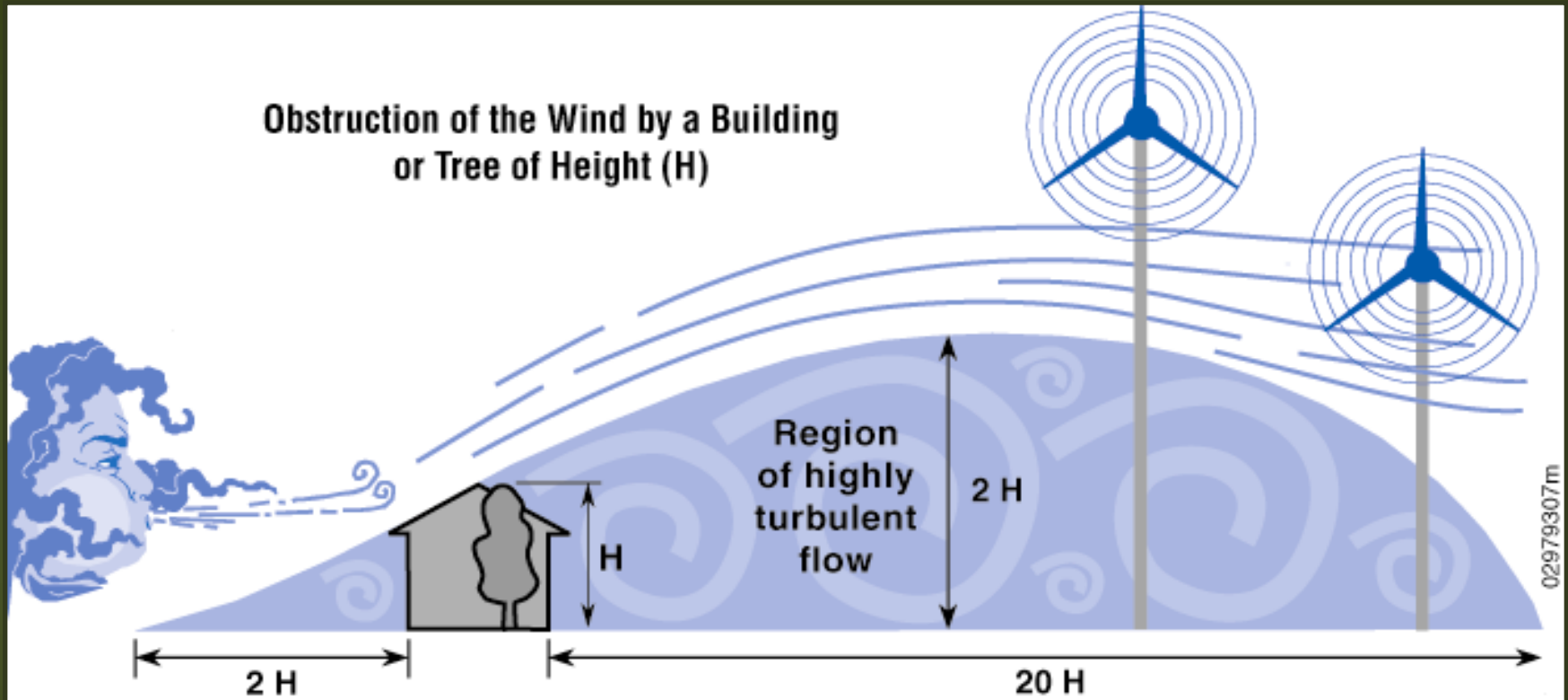
Source: U.S. DOE, National Renewable Energy Lab

Net-metering for Grid-Connected Systems

- “Bank” excess energy with the local utility
- Meter spins backward; customer receives full retail value for each kWh produced
- Net excess generation (NEG) credited monthly or annually



Importance of “Micro-Siting”



Estimated 7% capacity factor in first 5 months of operation

(December, 2006 – April, 2007)



Example: Wind Turbine Installed Cost

Red highlights = Turbine System Cost



Updated: 5-Jul-07

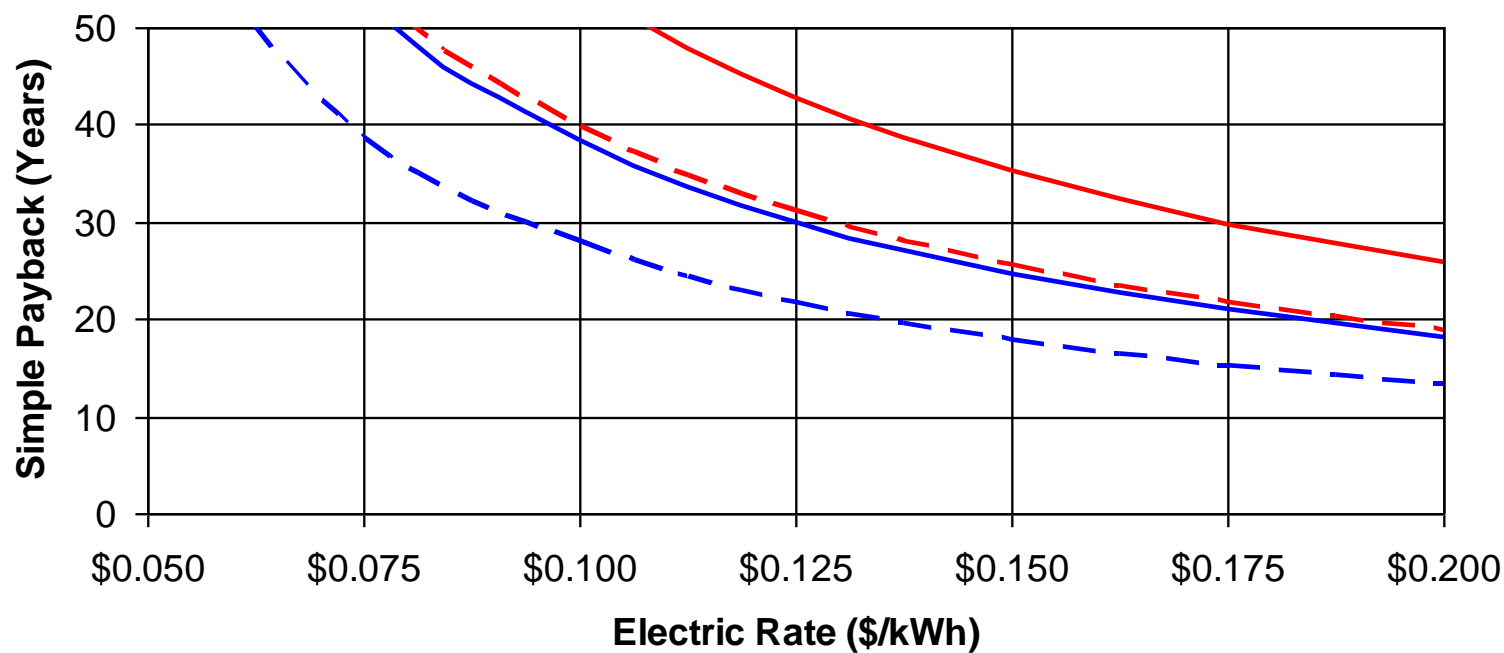
Bergey Excel-S (10 kW)

High Cost Low Cost

Wind turbine & inverter	\$27,900	\$27,900	\$27,900
Tower (100 ft guyed)	\$9,200	\$31,950	\$7,400
Tower Wiring Kit	\$1,000	\$1,140	\$860
Shipping	\$1,500	\$2,000	\$1,000
Installation	\$8,000	\$18,000	\$2,000
Permits/Fees	\$500	\$6,000	\$0
Sales Tax, 2%	\$952	9%	none
Total	\$49,052	\$94,279	\$39,160

Bergey Excel-S 10 kW

Simple Payback



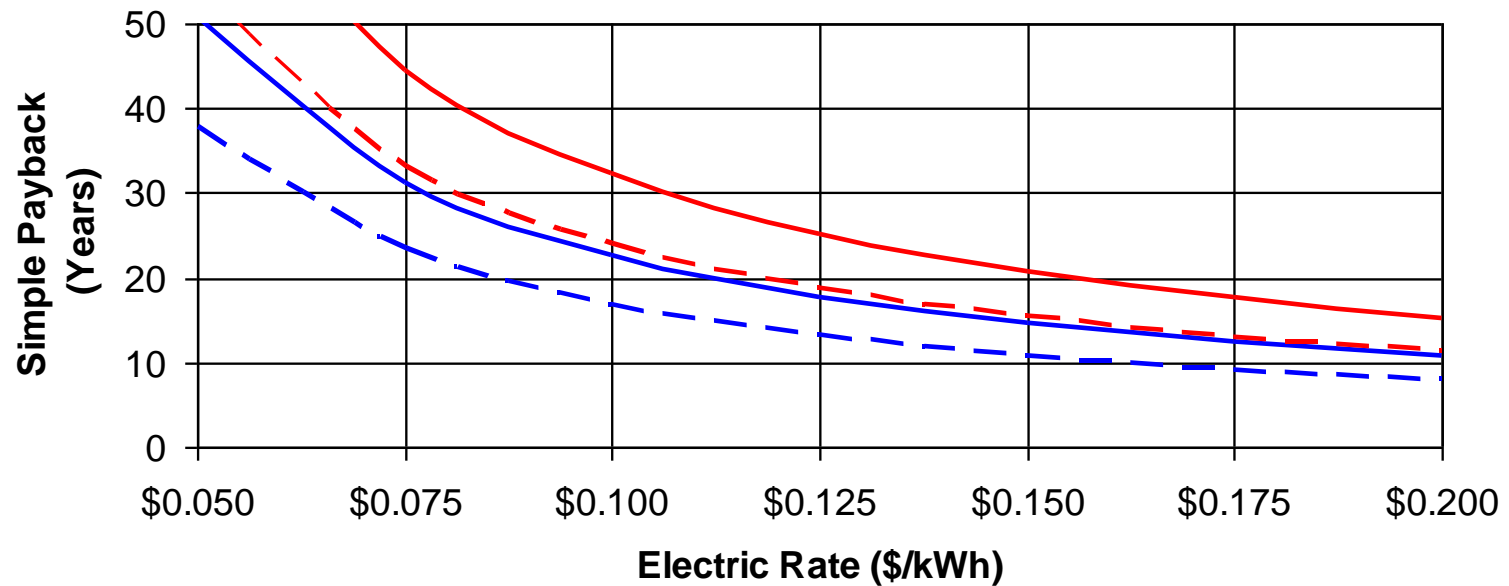
— Bergey Excel Class I/II — Bergey Excel Class II/III - - Bergey Excel Class I/II w/ USDA - - Bergey Excel Class II/III w/ USDA



Source: U.S. DOE, National Renewable Energy Lab

Entegrity 50 kW

Simple Payback



— Entegrity
50 kW
Class I/II

— Entegrity
50 kW
Class I/II

- - Entegrity
50 kW
Class I/II
w/ USDA

- - Entegrity
50 kW
Class II/III w/ USDA



Source: U.S. DOE, National Renewable Energy Lab

Grant and Loan Opportunities

- USDA Rural Development
 - REAP – Rural Energy for America Program
 - www.rurdev.usda.gov/rbs/busp/9006grant
- Indiana Office of Energy

- Please contact us with your questions

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